mated from impact experiments. Handbook values are used for Poisson's ratio, ν, and for the elastic wave velocity, c_0. These data make it possible to extract a hydrostat from the Hugoniot data, from which the coefficients in Eq. (19) are obtained by the method of least squares. Values of the parameters are given in Table 1 for aluminum and copper.

TABLE I

Parameters for the Elastoplastic Stress-Strain Relation

Material	μ_a	Y_0^*	M	A^*	B^*	C^*	C_0^{**}	ρ_0^{***}
Aluminum	0.00438	0.0025	0.055	0.755	1.29	1.2	0.640	2.785
Copper	0.00062	0.0007	0.031	1.495	0.55	11.8	0.503	8.936

*Units are megabars (10^{12} dynes/cm^2).

**Units are cm/μsec.

***Units are g/cc.

III. Results of Calculations

The waves generated by impact on a target of a strain-free projectile plate of thickness d are represented in Fig. 2. The figure represents a case in which the material exhibits no rigidity and entropy effects are negligible, i.e., the material is a particularly simple fluid. Coordinates in the figure are distance, x, and time, t. Trajectories of the front and back of the projectile are shown before impact as sloping, parallel lines. After impact, shocks propagate into both the target and the projectile. The backward-facing shock is reflected at the free surface of the projectile as a rarefaction centered at the point B in the figure, and is represented as being composed of four waves. These waves propagate forward through the projectile and cross the interface into the target. If the material in the target differs from that of the projectile, each wave is partially reflected at the interface, $ACFH$ . . . . The reflected waves interact with the incident waves (points D, E, and G in the figure). When both the projectile and the target materials are identical, the reflected waves have zero strength and the paths of waves

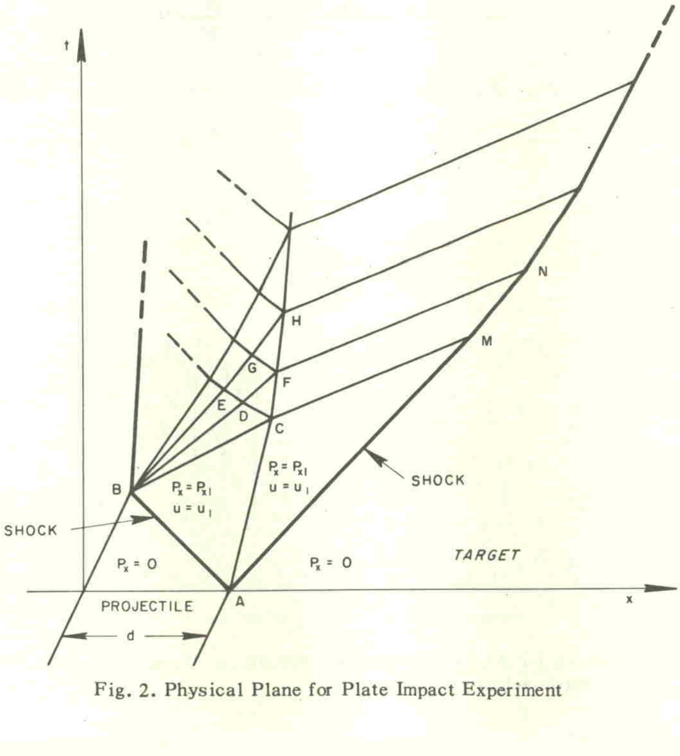

Fig. 2. Physical Plane for Plate Impact Experiment

from point *B* to their intersection with the shock front are straight lines. The first wave overtakes the shock at point *M* and reduces the pressure in the shock front. Precise measurement of the distance required for this interaction to occur would help in deciding whether the head of the rarefaction wave represented by *BCM* in the figure travels at hydrodynamic velocity or at elastic velocity.

The flow induced in a projectile and a target has been calculated by Fowles [6]. In the calculations it was assumed that entropy effects were negligible so that pressure was a function of volume only, and the velocity of the waves was assumed to be hydrodynamic. The calculations give, for example, the shape of the wave at any time, as shown in Fig. 3. The ordinate in the figure is the pressure, and the abscissa is the distance measured from the back side of the projectile at the instant it first contacts the target. Each wave profile is labeled with the time elapsed since the flying plate collided with the target. The projectile in this example was about 3 mm thick and had a velocity of 0.163 cm/μsec. Note that at a time of 3 μsec the wave has a flat top. This wave decays to a triangular wave of smaller amplitude but of greater duration. The decrease in amplitude of the wave is called attenuation in this paper.

Some results obtained by using the *Q*-method and the elastoplastic relations are shown in Fig. 4. These results are in the form of stress profiles, that is, stress is shown as a function of the distance for different values of the time following impact. Distance is an Eulerian coordinate in this and the following figures and is obtained from the calculations. The origin of the Eulerian coordinate is the same as the origin shown in Fig. 2. Profiles are given in

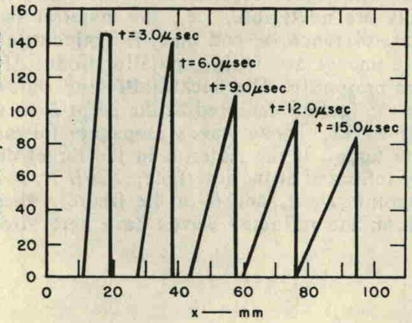

Fig. 3. Profiles of Pressure Behind Shock at Fixed Times (From Fowles)

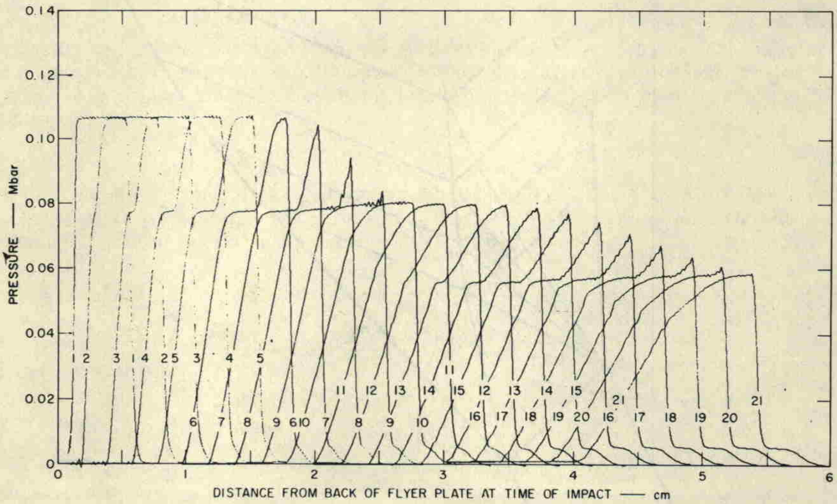

Fig. 4. Profiles of Stress for Aluminum Projectile Hitting an Aluminum Target. Projectile thickness 0.322 cm. Projectile velocity 0.125 cm/μsec.